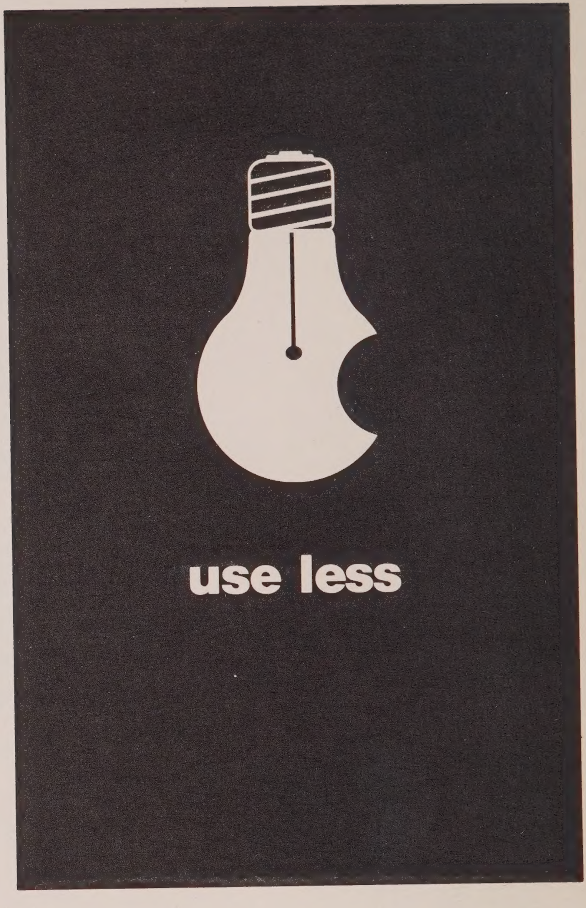
Ontario
Ministry of Colleges and Universities

energy management checklist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Hon. Harry C. Parrott, DDS, Minister
Dr. J. Gordon Parr, Deputy Minister

Introduction

The Ontario Government recognizes urgent need, both ecological and financial, to reduce consumption of energy — especially energy that is produced from irreplaceable fossil fuels. The Ministry of Colleges and Universities and its associated institutions can contribute significantly to Ontario's efforts to save fuel and money.

This *Energy Management Checklist* is intended for all members of the college and univeristy community, including administrators, technical and maintenance personnel, faculty, and students. Included in the text are suggestions for better management of

1 waste prevention,

2 construction standards,

3 improvements to existing buildings, and

4 technical operation of plant and buildings.

Energy Management Checklist is a *working* guide designed for you to keep on your desk or to carry with you for easy reference.

Information and promotion

Successful management of energy in colleges and universities requires support from all levels of administrative and academic authority. A clear statement of energy management policy should be issued from the highest level.

Administrators should encourage faculty, staff, and students to suggest ways to reduce energy consumption. Campus and public newspapers should be informed of the ideas that result in energy saving. The physical plant department can, for example provide the campus newspaper with regular articles based on past and present energy costs and usage. On-campus "thermometers" or other displays can be prepared to show this month's (or this week's) energy use compared with that used during the same period a year ago.

Memos and other campus publications can urge everyone to report malfunctioning equipment, rooms that are excessively drafty or hot in winter, cold in summer. In winter, the need to dress more warmly to compensate for a lower level of heating should be emphasized.

Finally, it should be stressed repeatedly that energy conservation measures are here to stay as a permanent way of life!

Capital spending

Energy management can be grouped according to priorities of capital funds:

1 administrative measures that involve little capital outlay and can be implemented immediately (for example, more economic scheduling of occupancy, adopting more economic temperatures — higher in summer, lower in winter — and proper maintenance);

2 measures that require capital outlay but whose *immediate* cost saving justifies the expense;

3 measures involving capital outlay not readily recoverable but which would be attractive should energy prices increase. (Evaluate these measures but withhold action until warranted by price changes. Measures in this priority will often be feasible in new buildings.)

Organizing the institution

Two main committees are needed to organize the college or university community for efficient energy management.

The overseeing Technical Committee should involve the director of physical plant, technical personnel, and representative engineering or science faculty and students.

The Group Committee should be composed of both energy *users* and *operators*. *Users* of energy include students, faculty, staff and administration. *Operators* are the physical plant director and the technical maintenance and administrative staffs responsible for energy supply. Group committees may be formed by faculty or department, or they can be formed to represent campus buildings such as each of the teaching buildings, the residences, the recreation and administration buildings.

Another committee, a Student Energy Advisory Group, could suggest ways to save energy and ways to gain student co-operation for energy-reduction projects. An Energy Management Information Officer, appointed by the physical plant director from among his staff, could regularly give information and assistance.

The physical plant director should be in charge of implementing and evaluating energy management programs and should head the technical committee.

The physical plant director should also:

1 initiate the preparation of accurate, comparable records by divisions such as faculties, buildings, facilities (Bases such as "per student" or "per square foot of floor area" could measure energy quantities and costs.);

2 plan and obtain authorization for purchasing metering devices necessary to determine the statistical quantities mentioned above (Borrow an energy supplier's metering equipment if possible.);

3 direct and monitor maintenance programs;

4 accumulate cost data for physical plant budget changes required for an energy-reduction program;

5 prepare weekly or monthly comparison statements of fuel and electricity consumption;

6 institute daily reports of efficiency of all heating plant (Check closely the percentage of make-up water at the plants, that is, check returns being dumped and leaks in the system.);

7 prepare a chart or graph which plots daily hour-by-hour electricity requirements to find out peak demand periods (If not done daily, this should be done for two- or three-week periods at various times of the year.);

8 develop a detailed shut-down program to maximize energy saving at night, during holidays and semester breaks, and develop an abbreviated program for weekends.

Some "starter" ideas

The Technical and Group Committees can discuss energy-reduction projects using data supplied by the physical plant director. They can also initiate their own studies or discussions. Listed below are some "starter" ideas.

1 Institute and promote new comfort standards, for example, 21C (70F) in winter and 25C (78F) in summer. Lower the temperature of the domestic supply of hot water and encourage those using hot water to do so economically.

2 Schedule use of energy-demanding facilities to minimize the hours of use. Less energy is consumed during "standby" hours. Consider rescheduling extra-curricular activities.

3 Adjust schedules to minimize travel between buildings.

4 Schedule daytime rather than nighttime cleaning and maintenance. If night clean-up crews are necessary, ensure that they turn off all lights except those that they actually need.

5 Establish uniform opening and closing hours for the maximum number of campus buildings and lock doors during "closed" periods.

6 Increase the use of some classrooms so that others may be closed temporarily.

7 Designate specific classrooms as study halls rather than allowing just any classroom to be used.

8 Concentrate regularly scheduled evening classes into fewer buildings.

9 Ban cooking in rooms.

10 Establish standards of energy use for each group or building, including "in-use" and "standby" loads. A heavy load may indicate a problem area.

11 Encourage the use of blinds or curtains to help insulate buildings from outside heat or cold. Closed blinds and curtains on south and west esposures will keep a building cooler in summer whereas opening them in winter will help to bring in some heat from the sun. Consider the use of double-glazed windows, painted and other heat-reflecting glass, or screening to lower the sun's effect on air conditioning. Consider shading devices and calculate if savings warrant the expense. Awnings can reduce heat gain up to 50 per cent in summer. Use roof overhang "eyebrows" and

other structural sun-shades over glass to reduce air-conditioning loads and to permit heat gain from low-angle winter sun. Plant trees to provide summer shade for buildings.

12 Check windows to see if they close properly and ensure that window frames are properly caulked.

13 Keep heating sources clear of furniture and drapery.

14 Use light-reflective colours in repainting. Use white or aluminum-coated roofs to reduce solar heat gain and lower air-conditioning costs.

15 Restrict the number of exterior doors used for normal passage. Consider vestibules.

16 Keep interior doors closed as much as possible to conserve heat in the rooms. Keep automatic door closers in good repair.

17 Review permitted elevator use.

18 Use aluminum foil-backed insulation or aluminum foil-backed gypsum board facing upward or outward to provide resistance to downward heat flow.

19 Check ceiling insulation under the roof; add more insulation and fill voids if insulation is below standard.

20 Seal all skylights and other roof openings as tightly as possible to reduce "chimney" effect.

Energy management for proposed buildings

Consider these energy-saving ideas when planning an addition or new building on campus.

1 Consider the effect of building an on-site supply of electricity, heating, and cooling. Compare capital and operating costs of independent heating and air-conditioning plant with service from a central supply system.

2 If appreciable summer occupancy is expected, minimize the building's exposure to sun.

3 Design buildings with the least possible perimeter wall area and maximum floor area and/or enclosed volume.

4 Ensure that new buildings are well insulated. Thermal conductivity of walls should not exceed .15 Btu/sq ft/hr (.013 Btu/m^2/hr). Thermal conductivity of roofs should not exceed .07 Btu/sq ft/hr (.006 Btu/m^2/hr).

5 Reduce the percentage of wall area to be glazed. Many office buildings are being reduced to 35 per cent and other types of building to considerably less. Use double glass. Use an economical type of reflective

glass in air-conditioned buildings. Provide shading for glass by using overhangs and side-shading fins. Determine heat loss per square foot of floor area and heat loss per cubic foot of enclosed volume, and compare with existing buildings; the result could be as low as 50 per cent or even less than the heat loss of traditionally designed buildings.

6 Choose heating, ventilating and air-conditioning systems to suit the periods and duration of occupancy of the building. Consider total air systems of a combination of direct heating and air systems, total air systems being more appropriate to continuous use and separate systems more for intermittent use.

7 Consider sub-division of the building so as to permit intermittent use of various areas.

8 Examine individual control provisions for economy of operation.

9 Consider the amount of exhaust ventilation proposed and the minimum amount of fresh air being provided. The balance should provide slightly positive pressure inside the building.

10 Check the minimum fresh air quantity against proposed occupancy on a cfm-per-person basis. Ten to 12 cfm (1.7 to $2.0m^3/hr$) per person for normal occupancy could be considered adequate.

11 Compare capital and operating costs of electric heating and fossil-fuel heating.

12 Consider installation of a heat pump if there is a reliable and adequate heat source in the building.

13 Evaluate heat reclamation by wheel or glycol solution run-around methods where amounts of exhaust ventilation are sufficient and the supply is relatively uninterrupted. The re-circulation of a large proportion of building air is the most efficient way to reclaim heat. Heat reclamation should be considered essential where large amounts of exhaust necessarily exist.

14 Design lighting in conjunction with ceiling arrangement and colour in order to achieve optimum efficiency. Determine and evaluate watts per square foot for various types of occupancy.

Heating, ventilating and air conditioning

1 Boiler plant maintenance:
a) keep a daily record of efficiency, fuel input, steam and heat output, flue-gas temperature, water treatment checks;
b) weekly, or more frequently, punch boiler fire tubes and operate soot blowers on water-tube boilers;
c) annually inspect boiler interior and settings and rectify if necessary.

2 Heating system maintenance: (Carry out maintenance procedures with special attention to servicing the entire heating plant when the load is off in the summer.)
a) annually inspect and correct leaks, damaged insulation, and check water and condensate condition;
b) annually clean and inspect traps, strainers, and expansion joints;
c) annually inspect convector element fins and, if necessary, vacuum clean.

3 Heating plant operation:
a) maintain highest efficiency;
b) conform to scheduling, "in-use" and "standby" conditions;
c) if the heating plant has been operated at times of the year other than the "heating" season, examine the reasons (Determine and evaluate measures to eliminate such operation and to shorten the heating season to an absolute minimum. Implement measures that can be reasonably justified economically and determine the point at which fuel cost increases will justify further changes.);
d) experiment with shut-down and start-up times (Shut-down as far ahead of scheduled "standby" period and start-up as soon before "in-use" period as is acceptable.);
e) between heating seasons, shut off supply mains as soon as possible to achieve maximum saving;
f) when feasible, shut down entirely those facilities that are not required for the winter season (Ensure the safety of buildings by carefully draining all water-filled pipes and equipment. Minimal heat may be required to maintain basements above freezing to prevent damage to foundations and structure.);
g) for optimum control of heating, consider using program clocks of dual element day/night thermostats.

4 Air-conditioning system maintenance:
a) regularly clean or change air filters as indicated by filter bank pressure gauges;

b) bi-annually inspect coils for leaks, clean if required, check temperature controls, clean air washer and adjust bleed.

5 Refrigeration plant maintenance:

a) determine shut-down times for winter and start-up for summer (Have machines pumped down and put out of use.);

b) periodically examine condition of water chillers, clean as required, and have elements examined, adjusted and rectified—consider occasionally using manufacturers' personnel for this service.

6 Ventilation and air-conditioning operation:

a) operate ventilation and air conditioning plant for highest efficiency and to conform to scheduling and to "in use" and "standby" conditions;

b) review fresh air quantities brought in by the systems at the minimum position and reduce this minimum fresh air intake to acceptable levels, 10 to 12 cfm (1.7—2.0m^3/hr) per person;

c) operate supply ventilation and air conditioning systems to provide free cooling in outdoor conditions below 13C (55F) and ensure that main refrigeration plants are shut down during the "free" cooling season;

d) abolish the use of heat in the cooling season (This type of operation is mainly present in terminal reheat types of air conditioning systems where heat is used for individual temperature control. Consider altering these systems to variable air volume.);

e) seasonally adjust discharge temperatures of constant-discharge air temperature systems to reduce controlling action required in variable-air-volume systems or reheat requirement for control where systems have not been altered to VAV.

7 Exhaust ventilation system operation:

a) where feasible, reduce air quantities;

b) turn toilet exhaust systems off at night and operate laboratory and specialized exhaust systems only when required;

c) evaluate exhaust hoods (New types are available which have their own outside tempered air supply and can effect economies.);

d) balance exhaust and fresh air supplies to provide a slight excess of supply air, thus reducing infiltration and drafty conditions at windows and doors;

e) survey exhaust and supply systems to determine feasibility of heat reclamation (particularly where supply air systems, operating at 100 per cent fresh air, have been provided to compensate for heavy exhaust ventilation required because of special circumstances).

Electricity

An electrical bill is usually made up of total energy consumption (kilowatt hours) and demand charges based on the rate of consumption (kilowatts). During peak loading, additional consumption can be very expensive because the demand charge usually far outweighs the normal value of the extra energy consumed.

Electrical peaks are established generally between 10 am and 3 pm (although the timing of these peaks may vary from campus to campus). If possible during this period, switch off equipment or at least refrain from starting additional equipment. Power in the "off" hours (that is, after 3 pm or before 10 am) is less expensive and it may be that some activities could be carried out during this time. The highest peaks occur on hot, humid days and on cold, dark days.

Billing structure varies with location. Become familiar with your particular electric billing structure and note:

1 demand figures;

2 consumption figures;

3 low power factor penalties;

4 unexplained differences between current and previous billing or between current billing and that of a comparable period during the previous year.

Become familiar with electrical demand patterns and determine the demands in various groups of buildings. Work to reduce demands and schedule to avoid coincidence of demands. Determine whether it is cheaper to supply negative reactive power on site or to buy power factor correction from the electrical utility. Relatively inexpensive capacitor installations can reduce peak demand, thus adding capacity to supply transformers or even to plant feeders; it can even raise voltage somewhat. (In practice, only three-phase loads need power factor correction.)

Review metering arrangements. If meters belonging to the local utility are to be used, it is best to have only one meter for the whole institution so that a single demand figure can be obtained. If two or more meters are used, billing will be based on the sum of the demands *whether or not* these peaks occurred at the same time.

Consider providing owner's meters for various groups of buildings; these should be demand and consumption types. Portable meters may also be used; these can often be borrowed from electricity suppliers for short periods of time.

To reduce energy consumption:

1 operate heating, ventilating and air-conditioning systems to conform with "in use" and "standby" conditions;

2 restrict air conditioning and heating to the shortest possible seasons;
3 schedule occupancy to obtain maximum efficiency in "standby" conditions;
4 exercise discipline in the use of lights and equipment.

Heavy consumption during laboratory operation, experiments or demonstrations should be scheduled for off-peak periods so that higher demand charges are not incurred. The acquisition of any electric equipment that could push consumption above the agreed level of electric demand should be considered carefully by the technical committee. The effect of this equipment on electricity cost should be assessed. Conditions governing periods of operation, including times and duration, should then be clearly specified.

Here are some steps that can be taken to reduce electrical consumption.
1 Modify all lighting levels to conform with new reduced Illuminating Engineering Society (IES) standards, with the cooperation and approval of users. Promote even lower levels of lighting in spaces other than work areas. Be aware that past IES standards may have been unduly high.
2 Operate lighting systems to coincide with "in use" and "standby" conditions.
3 Regularly clean lamps and fixtures to improve lighting efficiency. As part of preventive maintenance, take periodic readings with a light meter to check rate of deterioration of light output. Under average conditions, fixtures will collect enough dirt to cause light output to decline at least 2 per cent per month. Dirt and normal deterioration can reduce light output by more than 50 per cent in two years. Remove diffusers where glare is not a problem.
4 Improve light-switching arrangements for increased flexibility, using windows where possible for daylight. Encourage economical use of lighting. Increase promotional efforts to stimulate faculty, students and administrators to endorse the ideal of using lights only when needed.
5 Place "Lights Out" reminders at switches and exits. When light switches are conveniently located at restroom entrances, encourage their use as needed.

6 Reduce exterior lighting if this can be done without excessive risks to safety and security.
7 Consider reducing or eliminating decorative lighting.
8 Reduce corridor lighting in all buildings by disconnecting alternate fixtures or by some other means to conform to new lower lighting standards. Be aware that removal of one lamp from a two-lamp ballast will adversely affect the power factor and can result in penalty charges. Be aware also that removing all lamps from a switched-on ballast will still result in some wasted energy; the ballast must be switched off or disconnected. Fixtures to be left without lamps should be marked to prevent inadvertent relamping; lamp sockets should be taped to prevent insertion of lamps.
9 Replace incandescent street lights with mercury vapour or sodium lamps which produce more light and consume less energy.
10 Reduce parking lot lighting to minimum safety requirements; access to certain lots may be prohibited (entrances and exits barred) during evening hours so that all lighting can be eliminated in those areas. Deactivate automotive engine block heater outlets during mild weather.
11 Install automatic timers or photo-electric cells to control lights, particularly exterior lights.
12 Realign working hours, including custodial service, to make best use of daylight. Illuminate only a portion of an area, such as a gym floor, while custodial crews are cleaning. Have custodial staff clean buildings one floor at a time, using lights only while cleaning. Make sure that lights are turned off as work progresses to another floor. For most night cleaning, 20-25 foot candles (215-270 lux) of light are sufficient. Light switches providing only this amount of light should be identified; only these would be turned on while the area is being cleaned.
13 Have security, cleaning and maintenance personnel check for excess lighting left on after departure of custodial personnel; instruct them to turn off lights that have been left on and to report those that they cannot turn off.
14 Turn off outside stairwell lights during daylight hours.
15 Check to see that correct wattage is used in all fixtures including lights at exits, in restrooms and around building entrances.
16 Take advantage of natural daylight in your survey of lighting requirements, and instruct personnel to make it a habit to do likewise. Encourage the use of natural lighting in rooms which have windows.

17 Schedule lighting maintenance and relamping programs for periods other than peak-demand.
18 In new construction, design facilities to reclaim heat from lighting fixtures.
19 Install fluorescent lighting in place of incandescent bulbs wherever possible. A 40-watt fluorescent lamp provides approximately four times more light than an incandescent lamp of the same wattage. New designs in fluorescent lamps now permit more frequent turning on and off. Economies can be achieved if lights are turned off when rooms are vacated for more than seven minutes.
20 When repainting, paint all dark coloured interior walls and ceilings a light shade in order to improve surface reflection. In new construction or modernization projects, consider a combination of ceiling fluorescent lighting and light colouring to obtain more efficient lighting. With proper arrangement, 70-80 foot candles (753-860 lux) can be obtained, with 2-2.25 watts per square foot (.18-.20 watts/m^2) off floor area.
21 Special consideration should be given to employees who have visual problems or unusually difficult visual jobs. Consider and experiment with "task" Lighting (light fixtures located only in areas where tasks are performed), as opposed to "general" lighting, to reduce lighting load. A judicious combination of the two kinds of lighting gives good results with less use of energy.

Books and technical papers

A Bucket of Oil: The Humanistic Approach to Building Design for Energy Conservation
W.W. Caudill et al.,
Cahners Books, Boston, Mass.
1974, 87 pp*

A Critique of ASHRAE Standard 90—F: Energy Conservation in New Building Design
D.G. Stephenson
National Research Council
Div. Building Research, Ottawa, Ontario
August 1975, 19 pp*

A Guide to Monitoring and Controlling Utility Costs
Seymour G. Price
ENA Books, 1231 25th St., N.W.,
Washington, D.C. 20037
(includes forms & procedures for recording & analyzing utility costs) $12.50

A New Look at Modular Integrated Utility Systems
W.R. Mixon,
Oak Ridge Laboratory
Oak Ridge, Tennessee. Write: IDHA,
5940 Baum Square, Pittsburg, Pa. 15206
1975 (Paper presented at 66th Conference of International District Heating Association—June 1975)

BSIC/EFL News Letter
Building Systems Information Clearinghouse/Educational Facilities Laboratories Inc.
3000 Sand Hill Road, Menlo Park,
California, USA 94025
(Published quarterly)

Case Studies of Energy Use, Elementary & Secondary Schools
Building Systems Information Clearinghouse/Educational Facilities Laboratories Inc.
3000 Sand Hill Road, Menlo Park,
California, USA 94025
Oct. 1974, 20 pp (Part of BSIC/EFL Energy Workshop)

Citizen Action Guide to Energy Conservation
Citizens Advisory Committee on Environmental Quality
1700 Pennsylvania Ave., N.W.
Washington, D.C. 20006
(U.S. oriented but considerable useful data)

Climatic Information for Building Design in Canada
National Research Council of Canada,
Ottawa, Ontario 1970, 48 pp*

Comparative Heating Performance: Insulated School vs. Uninsulated School
D. Brotherson
University of Illinois, Urbana, Ill.
1968, 33 pp*

Conservation of Energy & Efficiency of Fuels
Consumers' Gas Company Library
May 1974 (Bibliography No. 29)

Conservation of Energy Through Optimized Building Control
John Mack
Institute of Power Engineers
June 1974, 9 pp* (presented to conference of Energy Conservation in Toronto)

Considerations in Utilizing Refuse Derived Fuels in Existing Boilers
H.I. Hollander, P.E.
Commonwealth Companies,
Reading, Pennsylvania

Cost and Energy Savings Opportunities with Heating, Air Conditioning and Lighting Systems in Schools
Electric Energy Association
90 Park Ave., N.Y., N.Y.10016
(Booklet Price 40¢ postpaid)

Design & Evaluation Criteria for Energy Conservation in New Building Design
(ASHRAE Standard 90-p)
American Society of Heating Refrigerating & Air Conditioning Engineers, Inc.
345E 47th Street, N.Y., N.Y.10017
January 1975, 63 pp

Design & Evaluation Criteria for Energy Conservation in New Bldgs.
U.S. Dept. of Commerce, National Bureau of Standards Washington, D.C.
Feb. 1975, 99 pp*

Design Concepts for Optimum Energy Use in HVAC Systems
Electric Energy Association, 90 Park Ave., N.Y., N.Y.10016
(Booklet Price 40¢ postpaid)

Effective Energy Utilization in Buildings
Paul R. Achenbach
Sept. 1973*

Energy Conservation
L.S. Germain,
Lawrence Livermore Laboratory, University of California, National Technical Information Services, U.S. Dept. of Commerce,
Springfield Va. 22161.
Nov. 1973, 108 pp*

Energy Conservation and Window Systems
Samuel M. Berman et al.
American Physical Society, National Technical Information Services, U.S. Dept. of Commerce, Springfield, Va. 22161
Jan. 1975, 99 pp* (Report of the summer study on Technical aspects of efficient energy utilization)

Energy Conservation Checklist for Universities & Colleges
APPA, Suite 510, 1 Dupont Circle, Washington, D.C. 20036,
22 pp* (Case histories, Checklists, Dept. of Defence suggested Energy Conservation Techniques plus Bibliography. Price $1.50)

Energy Conservation Guidelines for Existing Office Buildings
U.S. General Services, Admin. Public Buildings Service, Washington, D.C. 20405
Feb. 1975*

Energy Conservation: Guidelines for Action
Michigan Assoc. of School Administrators, Lansing, Mich.
April 1974, 58 pp

Energy Conservation in Buildings: Techniques for Economical Design
C.W. Griffith, Jr.
The Construction Specifications Institute Inc., 1150 17th St., N.W., Washington, D.C. 20036.
1974, 174 pp* (Price: $20/copy)

Energy Conservation in Public and Commercial Buildings
Richard G. Salter & D.N. Morris,
U.S. Congress.
pp 149-203* (Part of "Research, Development and the Energy Crisis")

Energy Conservation Methods and Programs in the Industrial Sector
1975, 41 pp*

Energy Conservation Program Guide for Commercial Buildings
Louis de Latour,
Louisiana Dept. of Commerce, National Resources & Energy Div., Baton Rouge, La.
Oct. 1975, 28 pp*

Energy Conservation Program Guide for Industry & Commerce
National Bureau of Standards, Washington D.C.
Sept. 1974, 212 pp* (Copy filed at Canadian Standards Assoc. Library, 178 Rexdale Blvd. Rexdale, Ont. M9W 1R3.)

Energy Conservation—The Capital Investment Needs for Building Rehabilitation for Non-Profit Educational Institutions (Paper No. 2)
Energy Task Force, 1 Dupont Circle, Suite 510, Washington, D.C. 20036.
April 1975

Energy Conservation Through Building Design & a Wiser Use of Electricity
Fred S. Dubin,
Dubin-Mindell-Bloome Associates, N.Y., N.Y.
June 1972, 18 pp*

Energy Conservation Through Infra Red
Energy Conservation Ltd., Toronto
1974, 13 pp*

Energy Crisis Bibliography
A Peter Opperman,
American Inst. of Architects,
1735 New York Ave., N.W.
Washington D.C. 20006.
(Price: $2.00 postpaid)

Energy, Environment and Building
J.P. Steadman (Director, ARC)
Cambridge University Press, N.Y.
1975, 287 pp (Price: $14.95, $5.95 paperback)

Energy Management Program
Edison Electric Institute, Conservation & Energy Management Division, 90 Park Ave., N.Y., N.Y.10016
(Very interesting ongoing series of case studies)

Energy Management Report
M.J. O'Brien, P.Eng., Operations Engineer,
Trent University, Peterborough, Ontario.
May 1975
(Presented at OAPPPA Spring Meeting held at Trent Univ.)

Energy Management Workbooks
4 Vols.
East Ohio Gas Co., Cleveland, Ohio
1974*

Energy Option Workshop Workbook
David Sage Inc.
Consumers Gas Co., N.Y. U.S.

Energy Utilization in Buildings Using Life Cycle Cost-Benefit Analysis
Building Research Institute, 2101 Constitution Ave. N.W. Washington, D.C. 20418
(Price: $5.00 copy)

Fuel Economy Handbook
National Industrial Fuel, Efficiency Services,
Graham Trotman Dudley Publishers,
London, England
1974* (Energy Data Book Series: Looseleaf)

Guidelines for the Conservation of Energy in Federal Buildings
Canada Depart. of Public Works, Ottawa, Ontario.
1973, 6 pp*

Heat Pumps—Application & Reliability
ASHRAE, 345E 47th St. N.Y., N.Y. 10017.
1972, 19 pp* (Technical Papers)

Impact of Heat Pumps & Heat Recovery Systems on the Heating Requirements of New Buildings
New York State pp III 19-32*
(From Study of Electric Space Conditioning)

Lighting & Thermal Operations, Energy Management Action Program for Commercial, Public & Industrial Buildings
U.S. Federal Energy Administration, Office of Conservation & Environment Washington, D.C. 20461.
Dec. 1974, 10 pp

List of Opportunities for Energy Conservation
U.S. General Services Administration AIA Workshops, Washington, D.C.
Nov. 1973

New Approaches to Energy Management & Lighting in Office Buildings
R.J.G. Hazen,
Canadian General Electric, Lamp Dept.
Nov. 13, 1975, 11 pp

New Energy Technologies for buildings
Richard Schoen et. al.
Ballinger Cambridge, Mass.
1975, 217 pp (Report to Energy Policy Project of the Ford Foundation)

Pre-Design Analysis of Energy Conservation Options for a Multi-Storey Demonstration Office Building
Tamami Kusuda et. al.
U.S. Dept. of Commerce, National Bureau of Standards, Washington D.C.
Nov. 1975, 60 pp*
(Part of NBS Building Science Series 78)

Principles of Economical Heating: How to operate & maintain a building and its heating system to gain greater comfort with minimum steam use
International District Heating Assoc.,
Pittsburg, Pa.,
1973, 55 pp*

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- Solutions to Problems of Energy Conservation in Existing Buildings pp 91-98
- Retrofitting 35 buildings on the Ohio State Campus for Energy Conservation pp 109-144
- Design Parameters for Energy Conservation in New & Existing Buildings: Gilbert Hellmer pp 185-210
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The Ohio State University, Columbia, Ohio.
May 1974, 343 pp* (Jointly sponsored by NSF,

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Drexel University, Philadelphia, PA.
June 1972*

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APPA, Suite 525, 1 Dupont Circle Washington, D.C. 20036

Rational Use of Energy in Campus Buildings and Resulting Savings
Université Laval, Ste. Foy, Quebec.
May 16, 1975 (Paper presented at 1975 CAUBO Conference)

Reducing Operating Costs in School Heating Systems
University of Illinois, Urbana, Illinois.
1970, 19 pp

Relight to Conserve Energy
GTE Sylvania, Fall River, Mass.
1974, 23 pp*

Report of Ad Hoc Committee on Energy Efficiency in Large Buildings
Office of General Services, State of New York, Albany, N.Y.
March 1973.

Report on Building Life Costs
Council of Ontario Universities and Ministry of Colleges and Universities
Nov. 1973, 78 pp

Research, Design, Construction and Evaluation of a Low Energy Utilization School: Phase 1 Interim Report, Research
National Science Foundation, Washington, D.C.
Aug. 1974*

Studies of Control Applications for Energy Conservation
Honeywell Inc.
39 pp*

Syska and Hennesey Technical Letter
Syska & Hennesey Inc., Engineers, 110 West 50th Street, N.Y., N.Y. 10020

Technical Options for Energy Conservation in Buildings
Report of Joint Emergency Workshop on Energy Conservation in Buildings
Order by number & name from Superintendent of Documents U.S. Government Printing Office, Washington, D.C. 20402.
1974, 175 pp (Price: $2.35 domestic postpaid)

Tell the Energy Crisis Like It is
W.L. Hartman,
The Ohio State Univ. IDHA, 5940 Baum Square, Pittsburg, Pa. 15206.
1975 (Paper presented at 66th Annual IDHA meeting in Skytop, Pa.)

The Economy of Energy Conservation in Educational Facilities
Educational Facilities Laboratories Inc., 477 Madison Ave., N.Y., N.Y. 10022.
1974, 82 pp (Manual containing detailed information on subject. Price: $2.00/copy)

The Effect of Window Air Leakage on Energy Conservation
George A. Devonshire,
Institute of Power Engineers
1974* (Paper presented to Conference on Energy Conservation, Toronto)

The Energy Crisis in Public Schools: Alternative Solutions
Venture County Superintendent of Schools, Venture, California.
1974, 78 pp*

The Optimum Thermal Resistance of Walls and Roofs
D.G. Stephenson,
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